PREDICTIVE PARTS MANAGEMENT FOR AVIATION AFTERMARKET.

Abstract

The article talks about major challenges faced by MROs, Airlines, and other stakeholders of the aftersales market in the aviation industry. The article briefly describes the current market scenario and potential future trends of the aftersales market in nearby future. The article discusses various need of MROs and Airlines like Zero AOG, Preventive Maintenance, Scheduled Maintenance and Aftersales parts availability to name a few, its impact on the overall business. It also discusses the potential features of a digital solution that can address the concern of the aviation industry in aftersales. It reflects on how the latest technologies like AI/ML, Blockchain, Big Data and Cloud Services can be leveraged in a robust digital solution. It highlights the Infosys expertise and capabilities in the digital solution space to provide such a feature-rich solution. The article concludes with the potential gaps in the aftermarket and how digital technology can contribute to reducing the gap.

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Introduction to MRO and Aircraft Parts Business

Maintenance, Repair and Overhaul (MRO) operations fall under the aftersales support and maintenance function. MRO helps keep aircraft in optimum usable condition, such that airlines and their customers do not lose out on opportunities because of aircraft downtime. MRO teams look after maintenance, repair, service, or inspection of an aircraft and/or its components. Whenever an aircraft is flown, its airframe, engines, and avionics systems age, i.e., various parts deteriorate or require periodic maintenance. Such activities are carried out by an aircraft MRO, to help ensure the airworthiness of an aircraft. To achieve this objective, MRO personnel keep incorporating preventive maintenance practices and inspections in line with the guidance provided by the Original Equipment Manufacturer (OEM), i.e., aircraft

manufacturer, in the form of Aircraft Maintenance Manuals (AMMs).

It is worthy to note that depending on the region where the aircraft operates, certain maintenance requirements change. For example, the guidelines in maintenance tasks performed on an aircraft flying in colder climates will differ from those flying in the Middle East. Hence, local regulatory bodies, such as Federal Aviation Administration (FAA), European Aviation Safety Agency (EASA), Directorate General of Civil Aviation (DGCA), etc., do a final review of AMMs. This exercise aims at keeping aircraft safety in check, with respect to different geographical regions. This ensures that maintenance work is done the right way and thus increases the reliability and airworthiness of an aircraft, based on its operating conditions.

Geographical change is one of the several complex factors that MRO teams need to address. The aerospace industry is focusing on ways to enhance MRO activities (e.g., Maintenance Steering Group-1 (MSG-1 through MSG-3) and is also in developing digital systems, such as preventive maintenance solutions. These systems help establish a balance between airworthiness and technical life of an aircraft.
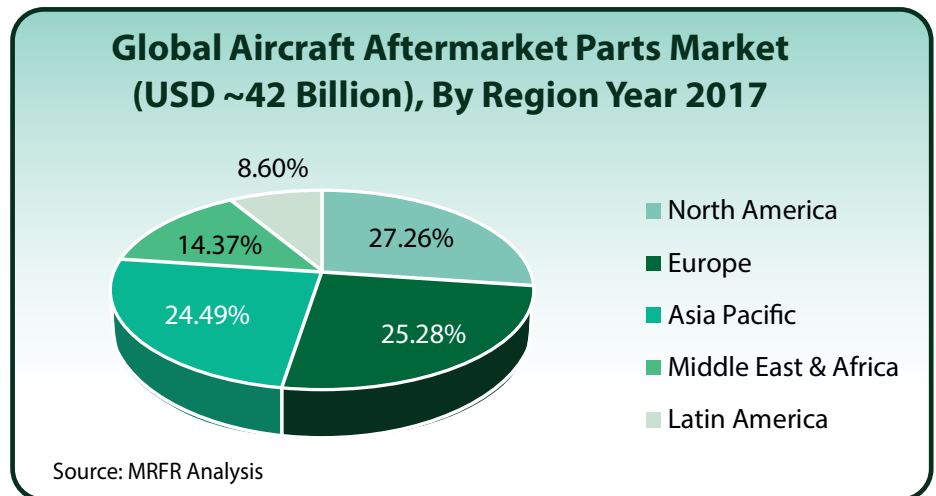
Aviation is a high value asset industry, and storing spare parts requires intensive capital investment. Ensuring the availability of the right part at the right time with minimum inventory storage costs is one of the crucial targets of every MRO organization. Several intrinsic factors make this task more complex. Therefore, aircraft parts business is in the spotlight of all stakeholders across the value chain.

Growth Potential of the Aftermarket Parts Market

The global MRO market is expected to record a Compounded Annual Growth Rate (CAGR) of 5.75 percent during the period of 2017 to 2023. The global aircraft aftermarket parts market was valued at around USD 42 billion in 2017. Within the aviation space, the engine MRO market is expected to reach USD 8,961.9 million at a CAGR of 8.98 percent by 2026 and the business jet MRO market is expected to register a CAGR of 3 percent during 2020-2025.

The following factors are poised to drive growth over the next few years:

1. Business jets that are currently in use are aging and will require more checkups and maintenance to comply with guidelines of regulatory bodies.

2. There are various new types of aircraft entering the business jet space, which will strengthen aftermarket growth in the coming years.

3. The demand for customization in private jets is on the rise. In addition, due to the pandemic, many airlines are planning to customize their cabins based on passenger demands and guidelines.

Global Aircraft Aftermarket Parts Market (USD ~42 Billion), By Region Year 2017

- North America — 27.26%
- Europe — 25.28%
- Asia Pacific — 24.49%
- Middle East & Africa — 14.37%
- Latin America — 8.60%
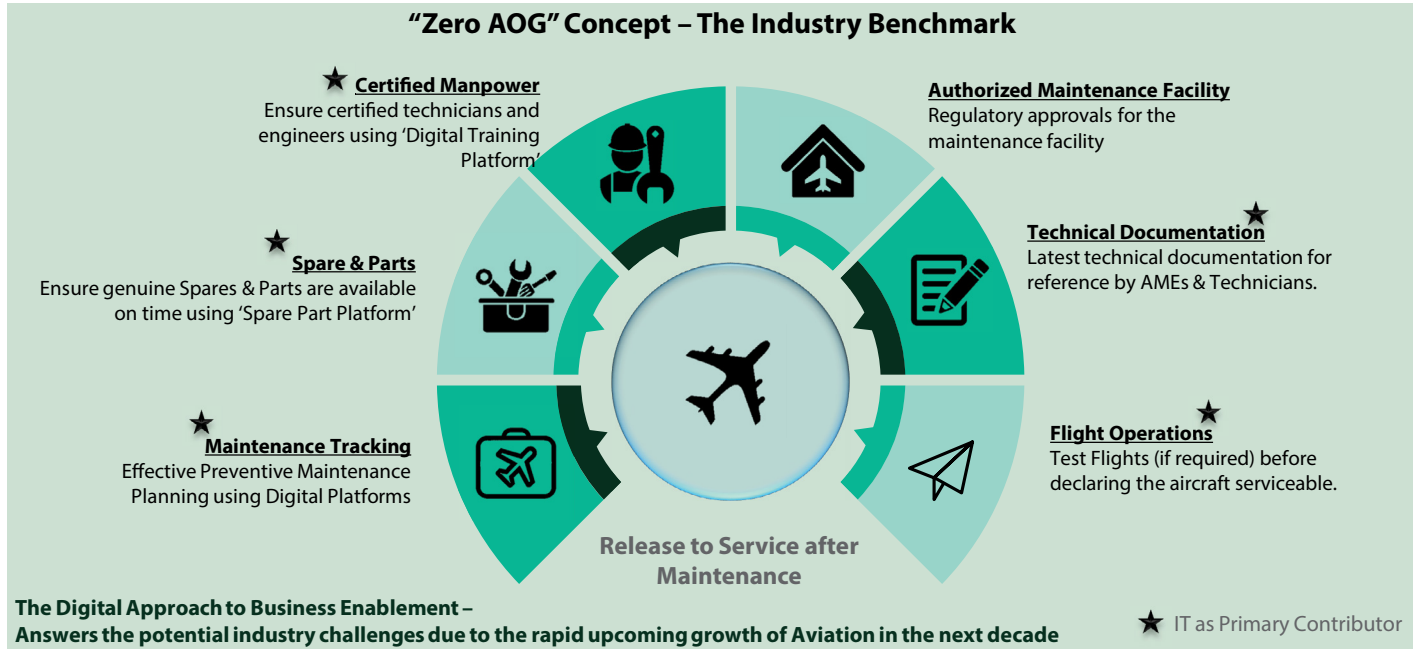
Source: MRFR Analysis

4. With new aircraft entering market, refurbishment of older aircraft will also contribute to considerable growth.

5. The MRO aftermarket is consolidated among very few players, thus creating a high potential for a new player to enter the market with new and competitive offerings.

There are some setbacks associated with the aviation industry which may impact the growth rate, such as availability of skilled labor. The industry is struggling with labor shortage, as maintenance and overhaul tasks which are prescribed by regulatory bodies require specific skillsets. This can hinder the industry's potential growths.

Challenges and Potential Opportunities

The utmost priority of any business is to utilize assets to their utmost efficiency, so as to incur optimal production costs and not lose out on any new opportunity. In case of the aviation industry, the uptime of an asset – which is aircraft – is its proper utilization or air worthiness. AOG (Aircraft on Ground) is an indicator that implies the aircraft is not fit to fly due to some technical failures or maintenance issues. Airlines and business jet owners always aim to minimize AOG and with the help of MRO companies, they try to achieve Zero AOG. Zero AOG indicates that aircraft uptime is maximum and there will be no loss due to non-availability of aircraft.

"Zero AOG" Concept – The Industry Benchmark

★ **Certified Manpower**
Ensure certified technicians and engineers using 'Digital Training Platform'

★ **Spare & Parts**
Ensure genuine Spares & Parts are available on time using 'Spare Part Platform'

★ **Maintenance Tracking**
Effective Preventive Maintenance Planning using Digital Platforms

Authorized Maintenance Facility
Regulatory approvals for the maintenance facility

★ **Technical Documentation**
Latest technical documentation for reference by AMEs & Technicians.

★ **Flight Operations**
Test Flights (if required) before declaring the aircraft serviceable.

Release to Service after Maintenance

The Digital Approach to Business Enablement –
Answers the potential industry challenges due to the rapid upcoming growth of Aviation in the next decade

★ IT as Primary Contributor

There are several factors which help achieve Zero AOG. One method is to incorporate proper planning and scheduling of maintenance of an aircraft. Industry 4.0 and IoT technologies are helping to a greater extent in addressing maintenance issues faced by the aviation industry. These technologies are helping with predictive and prescriptive maintenance and thereby reducing dependency on scheduled maintenance. To perform these maintenance activities, spare parts are required. Spare parts also play a key role in Zero AOG. Since aircraft parts are manufactured with high precision and involve extensive raw materials, the overall cost is very high. But when it comes to parts procurement for AOG, which is the utmost priority, buyers may end up paying hundred times the cost of product.

Cost Implication of AOG:

Cost of AOG ??

$150k / Hr. (Peak Cost) | $80k (Avg Loss/AOG) | $ 1.2 Mn/Day | $31 Mn Loss in 2007

Therefore, it became necessary to not only predict the preventive maintenance but also the spare parts required so that airlines and business jet owner invest the minimum required capital in maintaining their spare part inventories.
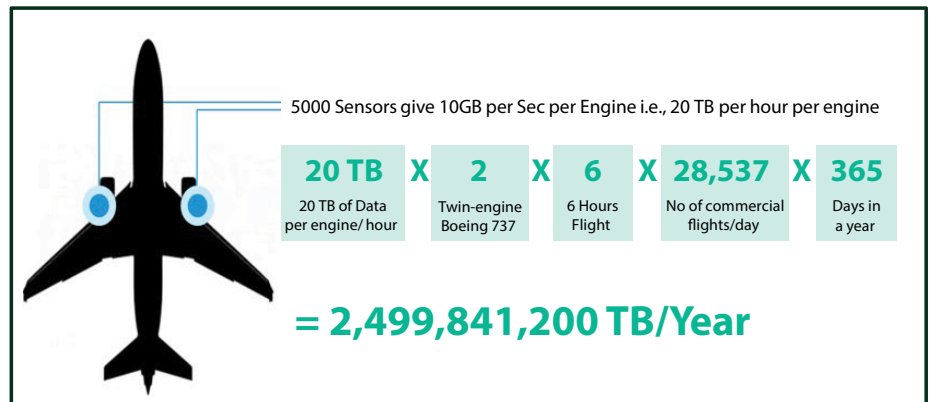
Recommended Capabilities/Features

All products and solutions need to cater to the pain points along with minimum viable features required to perform a task. With reference to Kano Model, a solution should have Baseline Expectation, Linear Satisfiers and Delighters. Baseline Expectations and Linear Satisfiers have become average expectations from customers. Delighters are the features that attract customers towards a product or retain an existing customer. Similarly, for e-commerce platforms in the aviation industry, these features can be broadly divided into four categories:

E-Commerce Basic	E-Commerce Advance	Special Add-On	MRO/Flight Operations
☐ Subscription Model	☐ Scenario Simulation – Forecast Demand	☐ Cost Estimation	☐ Exchange
☐ ERP Integration (Buyer/Supplier)	☐ Purchase Recommendation	☐ Pooling (Optimized Asset Utilization for Revenue Generation)	☐ Loan/Lease/Rental
☐ Adv. Part filter options	☐ Sale Recommendation	☐ Engg. Solution & Technical Support (Expert Connect/Assistance)	☐ Repair
☐ Compliance Management	☐ No Ghost Listing and Counterfeit Part	☐ Tooling Support	☐ Labor Hours Tracking
☐ RFQ, RFI, RFE and other pricing request	☐ Product Quality Management	☐ Additive Manufacturing	☐ Logbook Tracking
☐ Supplier Ratings	☐ Long Term Fixed Price Agreement	☐ Technical Documentation	☐ Maintenance Scheduling
☐ Fair Pricing	☐ Warranty Handling	☐ Training (Incl. Specialized & Seminars)	☐ Manuals
☐ Supply Chain (Tracking Order)	☐ Min/Max monitoring for Inventory Control	☐ Mobility (Order Placement through Mobile Devices)	☐ Service Bulletins
	☐ Broadcast to IATA and Other Resources	☐ Bid Management	☐ Work Order Management
	☐ Part Forecasting	☐ Package/Kit (Standard & Customized)	
	☐ Parts/Components Lifecycle Tracking	☐ Active Procurement Manager (AI Based)	

As shown in the chart, different features are broadly divided into four categories – E-Commerce Basic, E-Commerce Advance, Special Add-On, and MRO/Flight Operations. These are the features which have been available for a longtime and are becoming less efficient in serving the required purpose. For instance, Supplier Rating in majority of the platforms today is measured according to the customer feedback received for a service/product. It is a direct response from a customer, as requirements and expectations of customers differ from one another. Therefore, it is required to be updated with other factors like Fair Price offered by supplier/vendor, Transportation Capabilities, Parts Availability and Lead Time for Order and Parts Returned, and Complaint Trend. Similarly, most the features can be improved with the help of new technologies like AI/ML, Blockchain, and Big Data.

It is also required to store data related to aircraft and parts required in a tech-driven system, to predict the trend of maintenance and suggest preventive maintenance measures whenever required. On an average, an aircraft can generate 10 GB per second per engine, i.e., 20 TB per hour per engine. Hence, to handle such humongous and sensitive data, it is required to consider some modern techniques while storing and analyzing data. Some of these technologies are Blockchain, Big Data, and AI/ML.

5000 Sensors give 10GB per Sec per Engine i.e., 20 TB per hour per engine

20 TB	X	**2**	X	**6**	X	**28,537**	X	**365**
20 TB of Data per engine/ hour		Twin-engine Boeing 737		6 Hours Flight		No of commercial flights/day		Days in a year

= 2,499,841,200 TB/Year

The primary objective of Blockchain technology is to inculcate trust within a system where exchanges of sensitive and confidential data happen. It helps prevent manipulation and theft of data in any manner. Blockchain can be used to track parts, parts history, and usage, along with the data received from the aircraft engines – which are required to be stored for further analysis.

AI/ML will be helpful in analyzing the buying pattern and part consumption pattern and suggesting alternative options. Most importantly, it helps with the preventive maintenance required from time to time, based on performance of parts.

Big Data is very helpful in handling large volumes of data which may

be generated through different sensors and engines of an aircraft. This helps suggest logistic models, calculate costing, lead time, suitable transportation mode, etc. Cloud-based services will complement Big Data by providing real-time information to analyzing systems and maintaining a single source of truth.

Technology leveraged

1) AI/ML	2) Big Data Analytics	3) API Integration	4) Cloud Based	5) Blockchain
• Store, analyze and suggest alternatives • Track buying pattern and preferred partners.	• Logistic models • Costing/ Lead Time • Warehousing/Transport	• Hook on with existing Infra • Seamless integration and usage	• Real -Time Information • Single version of Truth • Global Reach	• Parts (LLP) Manufacture - Repair - Usage - Reuse - Decommissioning Records

Benefits

The need of the hour is to adopt an analytics-driven digital ecosystem which seamlessly networks all the stakeholders onto a common platform across the aviation value chain. Through such a platform, stakeholders can realize several benefits:

• High parts visibility, which strengthens fair market value and helps reduce counterfeit parts and aircraft downtime

• Effortless warranty management

• Excess spares resale opportunities

• Lower mark-up prices on parts

Further, faster and transparent information will drive superior forecasting capabilities, thereby cutting down inventory holding costs and IT infrastructure investments drastically.

A brief coverage on some of the unique features of this high-end digital ecosystem:
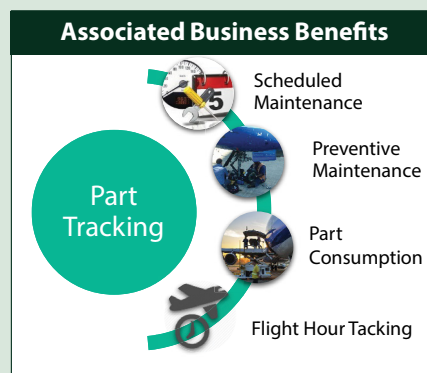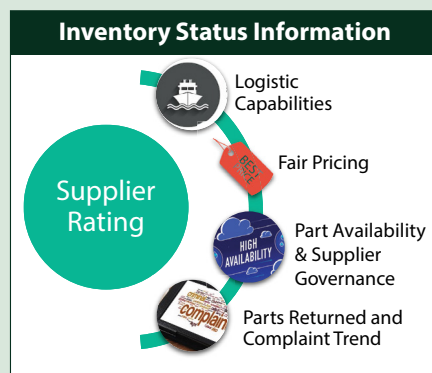
Supplier Rating

A well thought-out, need-based and configurable/ customizable supplier rating mechanism should replace standalone supplier rating systems. This provides enough flexibility to rate suppliers across parameters that matter the most to them, when clubbed with Supplier Risk Management through regulatory bodies. For e.g., for some buyers, lead time is more important than fair pricing parameter.

Parts Lifecycle Tracking

To ensure on-time delivery of spare parts and maintain optimal inventory levels in parallel, organizations can leverage a high-end digital solution with enhanced capabilities. This platform can dynamically recommend sale/purchase of parts based on maintenance activity schedules, consumption patterns, etc. Clubbing this with blockchain technology to have a single source of unalterable truth to track the history of parts/components can help combat counterfeit parts.

Fair Pricing

Transparent pricing improves chances of product acceptance and thus enables faster order conversions and improves cash flows. Disparity in pricing impacts a supplier's authenticity in the long run, ultimately leading to loss of business. Therefore, organizations must adopt highly efficient, analytics-enabled high-end solutions to recommend price based on analysis, comparison of market trends like product availability (seasonal/non-seasonal), geographical location, demand, prevalent prices, etc.

Inventory Status Information

Supplier Rating
- Logistic Capabilities
- Fair Pricing
- Part Availability & Supplier Governance
- Parts Returned and Complaint Trend

Associated Business Benefits

Part Tracking
- Scheduled Maintenance
- Preventive Maintenance
- Part Consumption
- Flight Hour Tacking

Spare Parts Demand Management

Fair Pricing
- Market Price Parity
- Best Price for All
- Faster Negotiations
- More Satisfied Stake Holders

Infosys' Readiness and Capabilities

The ability to provide a solution that is cognizant of domain presence and brings in superlative IT skillsets is one of the core competencies of Infosys. Infosys has a team of Subject Matter Experts (SMEs) with excellent industry expertise along with IT experts who have a proven track record of delivering complex digital solutions across industries.

The digital platform must have the potential to help *open up new business opportunities* to onboard small fabricators, repair centers, and additive manufacturers. Our *feature-rich solution* will create huge revenue opportunities by overcoming current shortcomings in parts management practices, such as counterfeit parts, price discrimination, parts lifecycle tracking, and supplier performance, among others.

Our global presence has a geographical advantage, as it enables us to create inventive solutions that help MROs in taking on advanced services and driving better business.

Over the years, Infosys has acquired profound domain expertise in building top-notch digital solutions that suit the unique requirements of enterprises. Prior to execution, Infosys dives deep into the prerequisites of business partners and utilizes this intelligence to drive faster client adaptability. This association helps set up, measure, and acknowledge advantage from the new framework rapidly.

Conclusion

The MRO industry is striving to ensure airworthiness of aircraft. This endeavor includes making sure that the scheduled or predictive maintenance activities are followed, tracked, and executed perfectly, under all circumstances, in any location, to reduce AOG. This calls for a mechanism that maximizes the technical life of aircraft parts and their availability at the earliest, without increasing the cost of inventory and simultaneously reducing the cost related to delays and AOG.

As per our study, the capabilities and features that have been analyzed and summarized show a remarkable gap between the ideal and the available options. The market does not have adequate features which ensure seamless connect between all the stakeholders on a common platform across the aviation value chain.

Leveraging industry experience and a detailed study of available options and the future that is possible with new-gen technologies like AI/ML, Blockchain, and Big Data analysis, we can easily reduce the gap between the ideal and current states.

Today's MRO professionals and other stakeholders across the supply chain must be equipped with a robust, intelligent system that helps in decision-making across avenues like fair pricing, parts lifecycle tracking, supplier performance, timeline accuracy, preventing counterfeit parts, etc., at the touch of a button.

Infosys has the capabilities and expertise required to build such cutting-edge digital technologies, through internal Center of Excellences (CoEs) built around cloud, automation, cybersecurity, IoT, blockchain, Big Data analysis, etc. We will also leverage our strong partnership ecosystem around the world, to create a WIN-WIN-WIN situation with our offerings for clients in the aviation industry.

Glossary:

AMM: Aircraft Maintenance Manual

AOG: Aircraft on Ground

CAGR: Compounded Annual Growth Rate

COE: Center of Excellence

DGCA: Directorate General of Civil Aviation

EASA: European Aviation Safety Agency

FAA: Federal Aviation Administration

MRO: Maintenance Repair and Overhaul

MSG: Maintenance Steering Group

OEM: Original Equipment Manufacturer

LLP: Life-Limited Parts

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Rajat is an Associate Consultant in Aerospace and Auto domain, with an experience of 4+ years in Aerospace & Auto, Renewable Energies and Additive Manufacturing. He has worked on Advance Manufacturing Technologies like 3D Printing, along with specialization in Digital Supply Chain Solutions. He is a Mechanical Engineer with an MBA degree in Marketing and Operations.

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Rahul is an Aviation Consultant with 15 years of experience in Industry Domain Consulting and Engineering for global organizations across multiple geographies, specializing in Digital Technology Transformation solutions. Along with consulting experience in complete business value chain from design to built to after-market support & services, he has rich hands-on experience in PDM/PLM tools with domain expertise in Product Engineering & Development, Planning & Manufacturing engineering, Supply Chain and Procurement.

He has expertise in ideation and solution conceptualization, business process optimization, As-Is & To-Be model creation. His Product Eng. & Development and Planning & Mfg. engineering experience bridges between Pre-production, Production and Post production processes which helps in building point solutions that can resolve existing business challenges for Aviation industry by leveraging IT.

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Dweepan Kirubairaj is a Consultant with Infosys Manufacturing Domain Consulting Group with vast experience in the Aerospace and Hi-Tech Industry. He has rich experience working in several IT transformational projects and building products for OEM, Airlines, and MROs across the globe. He has expertise in product design, solution advisory, conceptualization, and business processes with technical expertise in building various solutions across the complete value chain. Dweepan's passion for building solutions and products drives him to be conversant with the latest industry trends and technological innovations.

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Jai has 12+ years of experience in various areas of supply Chain which includes, Logistics, Warehousing, Inventory management across CPG (Consumer Packaged Goods), Pharmaceutical, Logistics and other sectors. His experience involves consulting services for Digital Transformation, Business Process Modelling, Project Management, Industry Analysis and Customized Solution Designing. He is also CSPO certified.

During his tenure as market research expert, he had written couple of articles, advisory and thought papers viz. "Article on Indian Logistics Challenges", "Article on World Air Cargo Market-2012 and Beyond", "Advisory on Impact of New Dry Bulk Terminal@Kandla Port" etc.. Jai is a MBA in Operations from Department of Management Studies (National Institute of Technology), Trichy, India. He has done his graduation in BS Marine Engineering from BITS Pilani, Rajasthan, India. As a Marine engineer, Jai had an opportunity to work across vibrant cultures of nationalities like Americans, South Koreans, Filipinos, Chinese etc.

Reviewer

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Amitav is responsible for growing the Aviation Consulting footprints at Infosys. He brings with himself valuable experience across defense, commercial and general aviation. He is a firm believer in improving the life of every member of the aviation fraternity. He has been a key contributor in building various solution across the business value chain. Currently, he conceptualizes new Mechanical digital solutions for the industry that can address present and forthcoming business challenges. He completed his B.E. in Engineering from VTU and holds a PGDM in International Business from Indian Institute of Foreign Trade, New Delhi. His interest includes painting and teaching

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